APPLICATION FOR
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FOR

AUTOMATIC BOTTOM-FILLING INJECTION SYSTEM

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BACKGROUND

1. Technical Field

The present invention relates to a novel apparatus and a method for automatically injecting fillings through multiple ports into the bottom of baked or fried goods having one or more cavities.

2. Description of Related Art

For years, bakers and confectioners have added fillings into pastries and fried goods such as éclairs, cream puffs, and doughnuts. The fillings typically comprise a viscous fluid such as jam, peanut butter, cream, mousse, caramel, or pudding. Prior art apparatuses and methods for injecting fillings into hollow or chambered goods typically involve manually operated, single-port injection devices.

Some prior art devices are as simple as a handheld, flexible, non-porous bag (such as a pastry bag) that has a stiff cone or tip capable of insertion into the food to be filled. In such a device, filling is squeezed from the bag, through the cone or tip, and into the vacant chamber or chambers of the food to be filled. Other prior art devices are semi-automated but still require a human operator to manually introduce an injection needle or nozzle into the interior of the food to be filled. They also require the operator to decide when the food has been adequately filled. For example, some prior art semi-automatic filling machines require an operator to slide a hollow food product onto a filling nozzle/needle, push a filling button to initiate filling, withdraw the product from the injecting machine as the filling is injected, and stop the filling when the product appears

to have adequate filling. Other semi-automatic machines can inject a predetermined amount of filling, but the operator still must manually determine when filling is complete and must manually remove the product from the machine. Removing product too soon from such devices will result in filling being placed on the exterior of the product. It is difficult to achieve consistent filling with such devices, as they depend on the judgment and skill of a human operator. The necessity of a human operator also increases operating costs, increases the opportunity for products to be damaged, and limits the maximum speed that would otherwise be available with an automated system. Furthermore, the injection nozzles/needles on such machines are limited to fairly blunt ends and large diameters in order to protect the safety of the operators. Blunt, large-diameter injection needles leave large and unsightly filling holes in the injected food items. These larger diameters also allow filling to undesirably leak out of the product.

While several prior art references disclose automated devices for filling food items, those devices are single-port injection only and cannot be efficiently used to fill food items having multiple filling sites. For example, U.S. Patent No. 3,871,274 granted to Hornby (the "'274 Patent") discloses a doughnut-filling device that uses a single needle to pierce the perimeters doughnuts and inject filling into their interiors. Similarly, U.S. Patent No. 6,468,572 B2 granted to Nelson et al. (the "'572 Patent") discloses a coring and filling device that uses a single-port injector to fill nuggets. Although the '572 Patent also suggests that it may be possible to inject multiple fillings either by using one depositing device to insert a mixture of different fillings or by using a separate injection device to deposit each type of filling into a single-cavity nugget, it does not offer an efficient solution for filling multi-chambered food items with a common filling.

Prior art single-port injection devices are not efficient for filling food items having multiple cavities, complex cavities or large cavities. Filling multi-chambered items with such devices requires separate single-port injection devices for each chamber or alternatively requires that each chamber be filled one at a time. It is expensive to operate separate injection devices for each chamber, and it is unduly time-consuming to fill each chamber one at a time with a single injection device. Furthermore, it is difficult to fill large or complex cavities with viscous filling using a single-port injector because higher pumping pressure is needed to force the viscous filling throughout such cavities. The higher pressures needed to distribute filling throughout large or complex cavities can undesirably damage the texture of the filling. Higher pressures also undesirably increase the tendency for filling to seep out from the injection site. Moreover, the additional handling required by this method significantly increases the opportunity for product damage.

In addition, prior art filling devices that inject filling from above, such as a device in accordance with the '572 Patent, or from the side (or perimeter), such as a device in accordance with the '274 Patent, leave unsightly filling holes that remain visible when the product is viewed from above or from a side.

Consequently, a need exists for an automatic food-filling device having a multi-port filling head that is capable of filling single-chambered and multi-chambered food items from the bottom. Such a device should be able to inject a predetermined amount of filling into the chambered food item. Such a device should also be able to divide a flow of filling among multiple injection needles so that each chamber of a multi-chambered food item can be simultaneously filled with at least one needle per chamber.

Alternatively, such a device should be able to quickly and efficiently fill a food item having a large or complex cavity by simultaneously injecting filling through two or more injection needles that are attached to the same filling head. Furthermore, by filling food items from the bottom, such a device should be able to fill food items without leaving unsightly injection holes that are visible from above or from the side. Automatic filling from the bottom will also reduce the occurrence of product damage due to operator handling.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, a multi-port bottom-filling injection device comprises a filling head having several spouts attached to a spout cap, a platen for holding a chambered food item, and a holding apparatus for securing the food item during filling. The injection device can simultaneously provide a food filling to each chamber of a multi-chambered food item without leaving unsightly fill holes in the top or side surfaces. Such an injection device can also be used to efficiently fill large or complexly chambered food items by simultaneously introducing two or more spouts or needles into each large or complex chamber and transferring filling through those spouts or needles. A multi-port, bottom-filling injection device in accordance with the present invention can be manually operated as a single unit or automatically operated as part of an automatic filling system.

Several multi-port, bottom-filling injection devices can be incorporated into an automated filling system. Automatic injection systems in accordance with the present invention use the following filling process to fill food items: 1) a plurality of chambered food items is indexed (conveyed) downstream on a platen conveyor; 2) each food item is positioned directly over a filling head; 3) a holding apparatus is positioned about each food item during filling to secure the food item; 4) a filling head raises so that its spouts pass through the spout channels in the platen conveyor and pierce the bottom surface of the food item being filled; 5) filling is pumped into the pierced food item; 6) if desired, a small amount of filling is retracted from the spouts to prevent filling from leaking out between injection cycles; 7) the filling head retracts until its spouts are below the platen conveyor; 8) the holding apparatus is removed from the food item; and 9) the filled food

item is indexed further downstream while the next chambered food item is indexed over the filling head.

The above as well as additional features and advantages of the present invention will become apparent in the following written detailed description.

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BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will be best understood by reference to the following detailed description of illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a side perspective view of one embodiment of a multi-port, bottom-filling injection device in accordance with the present invention;

Figure 2 is a side perspective view of the platen and spouts shown in **Figure 1**;

Figure 3 is a side perspective view of a star-shaped doughnut being held in place by the holding apparatus and platen shown in **Figure 1**;

Figure 4 is a side perspective view of the filling head from the multi-port, bottom-filling injection device depicted in **Figure 1**;

Figure 5a is a top perspective view of one embodiment of an automatic injection system in accordance with the present invention in which chambered food items are indexed along a single-lane platen conveyor and filled six at a time using six multi-port, bottom-filling injection devices;

Figure 5b is an enlarged perspective view of the filling heads, platen conveyor and doughnuts shown in **Figure 5a**;

Figure 5c is an enlarged perspective view of the rope conveyor running under the product and within grooves in the platens.

Figure 6 is a top perspective view of another embodiment of an automatic injection system in accordance with the present invention in which chambered food items

are indexed along a multi-lane platen conveyor and filled using one multi-port, bottom-filling injection device per lane to fill the food items; and

Figures 7a, 7b and 7c are schematic side elevational views, partially in cross-section, of an embodiment of a pumping system in accordance with the present invention.

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DETAILED DESCRIPTION

Multi-Port, Bottom-Filling Injection Device

A multi-port, bottom-filling injection device in accordance with the present invention has a filling head that volumetrically splits a flow of filling among two or more spouts or needles. Unlike prior art food filling devices, an injection device in accordance with the present invention can simultaneously provide a food filling to each chamber of a multi-chambered food item without leaving unsightly fill holes in the top or side surfaces. Whereas prior art devices had difficulty filling food items having large or complexly-shaped chambers, an injection device in accordance with the present invention can also be used to efficiently fill such food items by simultaneously introducing two or more spouts or needles into each large or complex chamber and transferring filling through those spouts or needles. A multi-port, bottom-filling injection device in accordance with the present invention can be manually operated as a single unit or automatically operated as part of an automatic filling system.

Figure 1 is a side perspective view of one embodiment of a multi-port, bottom-filling injection device **100** in accordance with the present invention. In the embodiment depicted in **Figure 1**, the injection device **100** is designed to fill a star-shaped food item (such as a star-shaped doughnut with a central hole) having five main filling chambers or cavities, which may or may not be interconnected. Thus, the injection device **100** depicted in **Figure 1** comprises a platen **110** having a star-shaped depression mold for receiving a star-shaped food item, as well as a filling head **120** having five spouts **122** (or needles) for injecting filling into each of the food item's five chambers. Note, however,

that while the embodiment shown in **Figure 1** shows star-shaped food items, other shapes are possible. The injection device **100** also has a holding apparatus **130** for keeping the food item firmly in place during the filling process.

Figure 2 is a side perspective view of the platen **110** and spouts shown in **Figure 1**. The platen **110** comprises a block, plate or tray made of a stiff, durable material such as metal, metal alloy, or hard plastic. While the platen **110** depicted in **Figure 1** and **Figure 2** is supported by several platen supports **112**, the platen **110** can also be supported by other means such as a conveyor. In a large-scale automated filling system, for example, a plurality of platens can be conveyed and supported along a conveyor belt. Furthermore, the platen **110** is not limited to the box or square shape depicted in **Figure 1** and can comprise any desired shape such as an oval, rectangle, star, or any other imaginable shape. The structural properties of the platen **110** are limited only by its function, which is to support and hold food items in proper alignment with two or more filling spouts **122** (or needles). Thus, it is more desirable for the top surface of the platen **110** to have a depression mold within which a food item can be snugly seated. The depicted platen **110**, for example, has a five-pointed star-shaped depression mold for receiving a star-shaped food item.

While the platen **110** only requires through-holes or spout channels **114** ("channels") of sufficient size and number through which the filling head's spouts **122** can pass, more channels **114** may be present, and each may be a larger size than necessary to accommodate various spout sizes, numbers and arrangements. For example, the platen **110** depicted in **Figure 1** and **Figure 2** has five elongate, radial channels **114** through which the embodiment's five spouts **122** can pass. The spout channels **114** of the

depicted platen **110** are wider than the diameter of the needles **122** and are elongate to accommodate various spout sizes and positions.

Figure 3 is a side perspective view of a star-shaped doughnut **140** being held in place by the holding apparatus **130** and platen **110** shown in **Figure 1**. The holding apparatus **130** in the depicted embodiment comprises five stems that extend downwards from a header. These five stems allow the doughnut **140** to be held firmly in place while the injecting needles **122** rise through the platen **110** and into the bottom surface of the doughnut **140**. The five stems are shaped and positioned so that when the holding apparatus **130** is placed in its holding position above the platen **110**, the stems abut the doughnut **140** along the five valleys (or crevices) that are interposed between the five chambers of the star-shaped doughnut **140**. By abutting the doughnut **140** along the five valleys where crevices and other surface imperfections might otherwise naturally form, the doughnut **140** is held in position with minimal surface damage. However, **Figures 1** and **3** merely depict one embodiment of the holding apparatus **130**. The holding apparatus **130** can comprise any structure capable of holding food items firmly in place upon the platen **110**. For example, the holding apparatus **130** can simply comprise a plate that is lowered to abut the top surface of a food item in position on the platen **110**. Alternatively, the holding apparatus **130** can comprise a platen **110** having a depression mold that conforms to the top surface of the food item to be filled. Furthermore, there are many acceptable methods for positioning the holding apparatus **130** over the platen **110** and the food item to be filled. Whereas the depicted holding apparatus **130** is hinged into place, other embodiments of the holding apparatus **130** are simply lowered into and raised out of position above the platen **110**.

Figure 4 is a side perspective view of the filling head **120** from the multi-port, bottom-filling injection device **100** depicted in **Figure 1**. The filling head **120** comprises a spout cap **124** for distributing a flow of filling among several spouts **122**, two or more (i.e. a plurality of) spouts or needles **122** that are attached at their bases to the top surface of the spout cap **124**, and a filling supply tube **126** that supplies the spout cap **124** with filling. In operation, the filling head **120** begins in a lowered position beneath the platen **110** and remains lowered during the placement and removal of a food item. After a chambered food item is placed upon the platen **110** and the holding apparatus **130** is lowered to secure the food item, the filling head **120** then raises so that the spouts **122** pass through the platen's channels **114** and pierce the bottom of the food item. Filling passes from the filling supply tube **126** to the spout cap **124**, from the spout cap **124** to the spouts **122**, and from the spouts **122** into the chambers of the food item. The filling head **120** then returns to its lowered position after the chambered food item is filled.

The spout cap **124** shown in **Figures 1** and **4** comprises a shallow cylindrical canister that defines an inner volume through which a flow of filling can be evenly distributed to several spouts **122**. Other shapes, however, are possible. For example, depending on the number of spouts **122** and their arrangement, the spout cap **124** can instead have a horizontal cross-sectional shape such as a triangle, square, rectangle, hexagon, or star. Any shape is acceptable for the spout cap **124** as long as it can distribute a flow of filling in the desired manner. For instance, a rectangular spout cap having some spouts closer to the center (or wherever the filling supply tube is attached) than others can be used to fill a food item having larger filling chambers in the middle and smaller filling chambers in the perimeter. The spout cap **124** can be made of any

food-grade material strong enough to withstand operating pumping pressures. Acceptable materials include but are not limited to steel, copper, titanium, and other metals or alloys, ceramics, and hard polymers.

The spouts **122** shown in **Figures 1** and **4** each have an elongate, cylindrical midsection and a tapered or conical injection tip. However, other types of spouts are possible. For example, the spouts **122** can instead have a conical shape, parabolic shape, or other shape. Furthermore, while the depicted spouts **122** have a circular cross-section, other cross-sectional shapes are possible, such as an oval, rectangle, cross, star, or any other imaginable shape. The type, size and shape of the spouts **122** depend on various factors including the type of filling to be added and the characteristics of the food item to be filled. For example, light and fluffy fillings such as whip cream are susceptible to shear thinning when exposed to high pressures. Thus, for such light and fluffy fillings, it is more desirable to use spouts with comparatively large diameters and large spout-tip openings in order to reduce the processing pressures necessary to transfer filling into a chambered food. It is also more desirable to use spouts that are as short as possible to reduce the amount of time that the shear-thinning-susceptible filling must spend compressed within the spouts. Such short spouts having comparatively large diameters and large spout-tip openings are also desirable for transferring very thick or viscous fillings, as well as fillings with small particulates. Viscous fillings and fillings having small particulates are less likely to plug short and wide spouts than long and narrow spouts. In contrast, it is more desirable to use narrow spouts for fillings that can handle higher pressures because narrower spouts are less intrusive, cause less damage to the bottom surface of food items, and leave smaller filling (or injection) holes. Smaller

filling holes are more desirable because they are less likely to allow filling to escape from the bottom than larger filling holes, and smaller holes also may be more aesthetically appealing.

The depicted spouts **122** have spout-tip openings located at the terminal ends of each spout **122**. However, the spouts **122** can alternatively have solid spout tips with the spout-tip openings located on the sides of each spout **122** near their ends.

Whereas manually operated, prior art filling devices were limited to blunt spouts (or needles) for safety reasons, a multi-port, a bottom-filling injection device **100** in accordance with the present invention is not limited to blunt spouts, regardless of whether manually operated or incorporated into an automated filling system. As explained above, the spouts **122** of an injection device **100** in accordance with the present invention can be kept in a lowered position below the platen **110** while placing and removing a food item. Thus, even if the injection device **100** were manually operated, the spouts **122** would never be exposed to a human operator. Consequently, an injection device **100** in accordance with the present invention can use very sharp spouts or needles without endangering human operators.

Like the spout cap **124**, the spouts **122** (or needles) can be made of any food-grade material strong enough to withstand operating pumping pressures. The spouts **122** must also be strong enough and sharp enough to puncture the bottom surface of the food item to be filled. Acceptable materials include but are not limited to steel, copper, titanium, and other metals or alloys, ceramics, and hard polymers.

If desired, the filling head **120** can include a positive shut-off mechanism for shutting off flow to the spouts **122** when the spouts **122** are not inserted into a food item.

This is particularly useful when the filling used is compressible, such whip cream. Compressible fillings sometimes continue to flow out of the open ends of the spouts **122** even after the pumping force is stopped because the filling, which compresses during the pumping phase, decompresses and expands after the pumping force is stopped. As it expands, it has nowhere to go but out the open ends of the spouts **122**. This post-injection filling flow can contaminate the device components and accumulate undesirably. Thus, a positive shut-off mechanism can dramatically reduce the amount of post-injection filling flow from the spouts **122** when such mechanism is placed relatively close to the end of the filling flow path, such as at the base of each spout **122** where each spout **122** meets the spout cap **124**.

In the embodiment of the filling head **120** shown in **Figures 1** and **4**, the filling head supply tube **126** connects to the center of the bottom surface of the spout cap **124**. However, the filling head supply tube **126** can connect to any portion of the bottom or side surfaces depending on the shape of the spout cap **124** and the desired distribution of flow. The filling head supply tube **126** can comprise a stiff or flexible tube and can be made of any food-grade material capable of withstanding operating pressures. Acceptable materials include but are not limited to metals, alloys, ceramics, polymers, and polymer-coated fabrics.

The platen **110**, filling head **120**, and other components can be heated or chilled to control the viscosity and shear-thinning properties of the filling as it enters the chambered food item. When transporting a thick or viscous fluid such as peanut butter, for example, the platen **110** and/or the filling head **120** can be heated so that the fluid's viscosity decreases, thereby making the fluid less resistant to flow and easier to transport. In

contrast, when injecting a fluid that is susceptible to shear thinning such as cream filling, the platen **110** and/or the filling head **120** can be chilled to help diminish the effects of shear thinning. Methods for heating and chilling equipment are well known in the art and need not be described in detail herein.

Note, however, that while the depicted embodiments are designed to fill a star-shaped doughnut, other complexly-chambered or multi-chambered food items having different shapes are possible, such as a ring-shaped doughnut having a toroidal filling chamber or a cross-shaped pastry having four filling chambers. The design of the injection device can be adjusted to accommodate differing shapes. To fill a ring-shaped doughnut having a toroidal filling chamber, for example, the platen **110** can be designed to have a ring-shaped depression mold for receiving such a doughnut. The filling head **120** can be manufactured to have several spouts **122** evenly spaced and arranged in a circle, and the holes or channels **114** can be provided in the platen **110** to accommodate those spouts **122**. The holding apparatus **130** can also be adapted to secure such a ring-shaped doughnut. For example, the holding apparatus **130** can instead comprise a flat disc or a second depression-molded platen. As illustrated by the previous example, the various components of an injection device **100** in accordance with the present invention can be modified to accommodate chambered food items of many different shapes.

Manually-Operated Bottom-Filling Injection System

The multi-port, bottom-filling injection device in accordance with the present invention can be used either in a manually operated system or an automated system. In a manually operated embodiment of the device **100** shown in **Figure 1**, for example, the

filling head **120** begins in the lowered position with the spout tips **122** within or below the spout channels **114**, and the holding apparatus **130** begins in the open position. An operator places a chambered food item onto the platen **110**, making sure that the food item fits snugly within the depression mold of the platen **110**, and then sets the holding apparatus **130** in the closed or holding position to prevent the food item from moving during the filling process. Next, the operator directs the filling head **120** to rise so that the spouts **122** pass through the spout channels **114**, puncture the bottom surface of the food item and enter the food item's filling chambers. This can be accomplished by physically moving the filling head **120** or by employing hydraulics, motor power, or a mechanical or electrical device. For enhanced safety, the injection device **100** can be designed to prevent the filling head **120** from departing from its lowered position except when the holding apparatus **130** is in place over the platen **110**. This helps prevent the operator from inadvertently contacting the spouts **122**. Once the operator has raised the spouts **122** into the chambers of the food item, the operator then pumps filling through the filling supply tube **126**, spout cap **124** and spouts **122** and into the chambers. While it may be desirable to pump filling into the chambers as quickly as possible, the operator should not pump the filling at such a high rate that the pre-existing air pockets within the chambers do not have time to dissipate. Pumping filling into the chambers too quickly may cause the filling to escape from the filling (injection) holes around the spouts **122**. Too great a filling rate may also damage the food item or even cause the chambers of the food item to explode. Thus, the operator preferably pumps filling into the chambers at a rate that allows air within the chambers to dissipate. The operator can also pause for a few moments after pumping has stopped to allow the trapped air to continue to dissipate,

as well as give the filling some time to set. Once the chambers have been filled, the operator then retracts the spouts **122** by lowering the filling head **120** to its lowered position. The operator moves the holding apparatus **130** back to its open position and then removes the filled food item.

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Automatic Bottom-Filling Injection System

In the preferred embodiment, several multi-port, bottom-filling injection devices in accordance with the present invention are incorporated into an automated filling system and are automatically operated. **Figure 5a** and **Figure 6** depict two examples of

10 an automated filling system **500, 600** incorporating several multi-port, bottom-filling injection devices in accordance with the present invention. It is important to note, however, that **Figures 5a** and **6** are merely illustrative of possible arrangements of an automatic bottom-filling injection system, and the possible embodiments are not limited to the two depicted examples **500, 600**.

15 Automatic injection systems in accordance with the present invention, such as those depicted **500, 600** in **Figures 5a** and **6**, use the same general filling process to fill food items. The general filling process comprises the following cyclical steps: 1) a plurality of chambered food items is indexed (conveyed) downstream on a platen conveyor; 2) each food item is positioned directly over a filling head; 3) a holding

20 apparatus is positioned about each food item during filling to secure the food item; 4) a filling head raises so that its spouts pass through the spout channels in the platen conveyor and pierce the bottom surface of the food item being filled; 5) filling is pumped into the pierced food item; 6) if desired, a small amount of filling is retracted from the

spouts to prevent filling from leaking out between injection cycles; 7) the filling head retracts until its spouts are below the platen conveyor; 8) the holding apparatus is removed from about the food item; and 9) the filled food item is indexed further downstream while the next chambered food item is indexed over the filling head.

Figure 5a is a top perspective view of one embodiment of an automatic injection system **500** in accordance with the present invention in which chambered food items **540** are indexed along a single-lane platen conveyor **516** and filled six at a time using six multi-port, bottom-filling injection devices **520**. Although the embodiment shown in **Figure 5a** indexes and fills food items six at a time, other embodiments can index and fill any number of food items at a given time, including one at a time. For example, in embodiments having only one multi-port, bottom-filling injection device, food items can be indexed and filled one at a time.

In the embodiment shown in **Figure 5a**, a plurality of star-shaped, chambered doughnuts **540** are supplied on a supply conveyor **550** and are evenly spaced into rows of six. However, as explained above with respect to **Figures 1-4**, the system components can be adapted to fill other types and shapes of chambered food items. The supply conveyor **550** deposits each row of six doughnuts **540** onto an adjacent platen conveyor **516** that runs perpendicularly to the supply conveyor **550**. The doughnuts **540** are spaced within each row of six so that as they leave the supply conveyor to be deposited on the platen conveyor **518**, each doughnut **540** is directly over a receiving platen **510** on the platen conveyor **518**. Any method may be used to transfer the doughnuts **540** from the supply conveyor **550** to the platen molds. For example, they can be transferred with the assistance of one or more robot arms, or they may simply be transferred by hand. Such

methods for transferring objects from a conveyor onto molds are well known in the art and need not be described in detail herein. Furthermore, although **Figure 5a** shows organized rows of doughnuts **540** being supplied on a supply conveyor **550**, the doughnuts **540** need not be organized in other embodiments. For example, in embodiments where the doughnuts **540** will be placed onto the platen conveyor **518** by hand, the doughnuts **540** need not be organized.

Interlaced with the platen conveyor **518** is a rope conveyor **516**. Each platen **510** has rope slits along its length so that the ropes of the rope conveyor **516** can run under the doughnuts **540** while the doughnuts **540** are in place upon the platens **510**. **Figure 5c** is an enlarged perspective view of the rope conveyor **516** running under the product **540** and within grooves in the platens **510**. The rope conveyor **516** begins from a point upstream of the platen conveyor **518**, interlaces with the platen conveyor **518** throughout the platen conveyor's length, and ends downstream of the platen conveyor **518**. Thus, the platen conveyor path is nested within the rope conveyor path. The rope conveyor **516** removes the doughnuts **540** from the platens **510** and supports the doughnuts **540** after the platens **510** descend and begin their return path at the platen conveyor's **518** downstream end.

The platen conveyor **518** comprises a plurality of depression-molded platens **510** that are flexibly linked to one another in series to form an endless conveyor. The properties of each platen **510** are as described above with respect to the multi-port, bottom-filling injection device **100** shown in **Figures 1** and **2**. In the embodiment shown in **Figure 5a**, the platen conveyor **518** indexes food items six at a time. This means that the platen conveyor **518** moves a group of six doughnuts **540** downstream and positions

them over the six injection devices **520** depicted. The platen conveyor **518** stops and waits for the six doughnuts **540** to be injected and filled. After filling, the platen conveyor **518** then moves the six filled doughnuts **540** further downstream and positions the next group of six doughnuts **540** over the injection devices **520**. The intermittent movement of the platen conveyor **518** is referred to as "indexing."

Once a group of six doughnuts **540** is properly positioned over the filling heads **520**, a holding apparatus (not shown) is placed down upon each of the six doughnuts **540** to prevent them from moving during the filling process. Each holding apparatus has the same characteristics as the holding apparatus described above with respect to the multi-port, bottom-filling injection device **100** shown in **Figures 1** and **3**. The holding apparatuses are then retracted after the doughnuts **540** have been filled. More specifically, the holding apparatuses can be retracted while or after the spouts retract from the doughnuts **540**.

The embodiment shown in **Figure 5a** has six filling heads **520** for injecting and filling indexed groups of six doughnuts **540**. **Figure 5b** is an enlarged perspective view of the filling heads **520**, platen conveyor **518** and doughnuts **540** shown in **Figure 5a**. In **Figures 5a** and **5b**, two doughnuts **540** have been removed to show the spouts **522** protruding through the platens **510** on the platen conveyor **518**. The filling heads **520** are spaced apart so that when the platen conveyor **518** indexes platens **510** directly over each filling head **520**, each filling head's spouts **522** are vertically aligned with corresponding spout channels in the platens **510**. This ensures that the spouts **522** can properly pass through the platen conveyor **518** to pierce the bottom surfaces of the doughnuts **540**. The characteristics of the filling heads **520** are as described above with respect to the multi-

port, bottom-filling injection device **100** shown in **Figures 1** and **4**. Like the filling head **120** shown in **Figure 4**, each of the filling heads **520** shown in **Figure 5a** and **5b** has several spouts **522** attached at their bases to the top of a spout cap. A filling supply tube is attached to the bottom of each spout cap.

A filling container **560** holds the filling to be injected into the food items. Although the filling container **560** shown in **Figure 5a** is an open-top container having a trough shape, other types and shapes of containers are possible, such as open or closed cylindrical, rectangular, and oblong tanks. The filling container **560** should be made of a food-grade material and be strong enough to contain the desired filling.

A pumping system **570** transfers a predetermined amount of filling from the filling container **560**, through the filling heads **520**, and into the chambered doughnuts **540**. The predetermined amount of filling depends on the volume of the food chambers to be filled. In any case, each chamber should receive no more filling than can be accommodated in that chamber. In one embodiment, the pumping system **570** does not begin to pump filling until after the spouts **522** have pierced the bottom surfaces of the doughnuts **540** to be filled. In another embodiment, however, the pumping system **570** begins to pump filling just before or as the spouts **522** pierce the bottom surfaces of the doughnuts **540**. Doing so helps compensate for any time lag between the instant pumping starts and the instant filling begins to exit the spouts **522**. The pumping system **570** transfers filling at a flow rate slow enough to allow the air that will be displaced by the filling to dissipate. Although not necessary, it is desirable to wait a short period of time after the pumping has ceased before retracting the spouts **522** from the doughnuts **540**. This time delay gives the air that is displaced by the filling more of an opportunity

to dissipate, and it also gives the filling some time to settle within the chambers of the doughnuts **540**. The time delay also compensates for any time delay between the instant pumping ceases and the instant filling stops flowing out of the spouts **522**.

There are many possible methods for controlling when the pumping system **570** starts and stops pumping a predetermined amount of filling as described above. Many of those methods are well known in the art and need not be described in detail herein. In the preferred embodiment, however, a rotating cam within a three-port valve is used to control the timing of the following: 1) when a piston draws a predetermined volume of filling into a piston cylinder; 2) when the piston transfers the drawn filling into a filling head supply tube; and 3) when the piston draws a small amount of filling from the filling head supply tube in order to prevent filling from dripping out of the spout ends when the spouts are not injected within a food item. U.S. Patent No. 4,752,488 (the "'488 Patent") discloses a similar device and method for controlling the timing of a pumping cycle. **Figure 7a** shows the position of a rotating cam **710** at the beginning of a pumping cycle as a piston **720** draws a predetermined volume of filling **730** from a filling container **740** into a piston cylinder **750**. **Figure 7b** shows the cam position at a later point in the pumping cycle when the piston **720** transfers the previously drawn filling **730** from the piston cylinder **750** into a filling head supply tube **760**. **Figure 7c** shows the cam position at the end of the pumping cycle, which also leads into the beginning of the pumping cycle. At the particular point of the pumping cycle shown in **Figure 7c**, the piston **720** is just beginning to retract, and the piston **720** withdraws a small amount of filling **730** from the filling head supply tube **760**. Shortly thereafter, but while the piston **720** continues to retract, the cam **710** returns to the position shown in **Figure 7a**. Then

the pumping cycle repeats, and the piston **720** again draws a predetermined amount of filling **730** from the filling container **740**. Although the cam **710** as shown in **Figures 7a, 7b** and **7c** rotates clockwise, the cam **710** can also rotate counterclockwise depending on the desired placement of the depicted components and the timing of the described actions. The rotation of the cam **710** can be linked to various actions and movements, such as the movement of the supply conveyor or another rate-controlling mechanism.

In the embodiments shown in **Figures 5a** and **6**, as well as in other embodiments not shown, an optical sensor can be used to detect the lack of a food item on any platen **510, 610** in position over a filling head **520, 620**. If such an optical sensor detects an empty platen **510, 610** over a particular filling head **520, 620**, filling flow to the filling head **520, 620** can be cut off or diverted to prevent filling from being supplied to the filling head **520, 620** when there is no food item in place to receive the filling.

Figure 6 is a top perspective view of another embodiment of an automatic injection system **600** in accordance with the present invention in which chambered food items **640** are indexed along a multi-lane platen conveyor **618** and filled using one multi-port, bottom-filling injection device (not shown) per lane to fill the food items **640**. The embodiment shown in **Figure 6** is similar to, and contains many of the same components as, the embodiment shown in **Figure 5a**. However, there are several major differences. Whereas supply conveyor **550** of the embodiment shown in **Figure 5a** deposits doughnuts onto a single-lane platen conveyor **518** that runs perpendicular to the supply conveyor **550**, the supply conveyor **650** of the embodiment shown in **Figure 6** deposits doughnuts **640** onto an adjacent, multi-lane platen conveyor **618** that runs in the same direction as the supply conveyor **650**. As explained above with respect to the

embodiment shown in **Figure 5a**, the doughnuts **640** can be transferred from the supply conveyor **650** and properly seated in the molds of the platen conveyor **618** in many ways, including the use of robot arms or human workers **680**. Rather than deposit, index and fill six doughnuts **540** at a time on a single-lane platen conveyor **550**, the embodiment shown in **Figure 6** deposits, indexes and fills doughnuts **640** on the multi-lane platen conveyor **618** one row at a time. There is one multi-port, bottom-filling injection device (not shown) per lane for filling the doughnuts as they are indexed downstream one row at a time. The filling heads of these injection devices are preferably located near the filling containers **660** and pumping systems **670** to minimize the distance that filling must be pumped. This helps minimize the damage done to fillings that tend to deteriorate from being pumped, such as fillings susceptible to shear thinning.

Whereas prior art automated filling systems use single-port injection devices to inject filling into the tops or sides of single-chambered food items, an automatic bottom-filling injection system in accordance with the present invention uses a multi-port, bottom-filling injection system to inject filling into the bottoms of single- or multi-chambered food items. The present invention provides a device and system for efficiently filling multi-chambered or complexly chambered food items that previously could not be easily filled. Furthermore, it fills food items without leaving unsightly injection holes on the top or side surfaces.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.